

Hymenopteran Pupal Parasitoids Recovered from House Fly and Stable Fly (Diptera: Muscidae) Pupae Collected on Livestock Facilities in Southern and Eastern Hungary

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ABSTRACT This field survey, the second noting the occurrence and diversity of filth fly pupal parasitoid fauna in Hungary, was performed on beef and dairy feedlots and swine facilities in the southern and eastern parts of the country. The filth flies *Musca domestica* L. and *Stomoxys calcitrans* (L.) were the two most commonly parasitized hosts. The three species of *Spalangia* recovered, in decreasing order of abundance, were *S. cameroni* Perkins, *S. nigroaenea* Curtis, and *S. endius* Walker. *Pachycrepoideus vindemiae* Rondani, *Trichomalopsis* sp., two apparently undetermined Diapriidae spp. and one apparently undetermined *Brachycera* sp. are believed to be new country records.

KEY WORDS *Musca domestica*, *Stomoxys calcitrans*, *Spalangia* spp., *Pachycrepoideus vindemiae*, Diapriidae spp., *Trichomalopsis* sp.

BECAUSE OF ITS location at the crossroads of eastern Europe, Hungary is a potential reservoir for insect species transported centuries ago from Asian and Middle Eastern areas by foreign invaders. The insects of interest to us are the synanthropic pest flies of humans, livestock, and poultry, and in particular the small wasps that parasitize the pupal stage of these flies.

Hymenopteran pupal parasites of pest species of muscoid Diptera have been collected and identified in many countries of the world (Legner et al. 1967, Legner and Olton 1968, Legner and Greathead 1969). Although Bouček (1963) published the first taxonomic records of indigenous filth fly parasitoid fauna from Hungary, our study in 1991 was the first formal survey (Hogsette et al. 1994). Results included new country records for *Spalangia endius* Walker and *Muscidifurax raptor* Girault and Sanders, two apparently undescribed *Trichopria* spp. and one apparently undescribed *Coptera* sp. (Hogsette et al. 1994).

This second study further investigated the occurrence and diversity of Hungarian protelean parasite fauna by collecting samples of potentially parasitized filth fly pupae from livestock facilities in areas of Hungary not surveyed in 1991. Results will provide more complete parasitoid species composition data from livestock operations and give scientists additional information for development of filth fly biological control programs in Hungary.

Materials and Methods

Collections were made in August when parasitoid populations would be expected to be large, and for comparison with the 1991 survey data (Hogsette et al. 1994). Visits to farms were limited to a maximum of 1 d because of time and labor constraints, and on most days collections were made on more than one farm. Nearly all collections were made in the southern and eastern regions of the country; however, results from a farm northwest of Budapest are also included (Fig. 1). Sampled farms were representative of the major confined livestock commodity groups and small private farms in the country. These included feedlot and traditional dairy, with samples collected from manure piles, hay, silage, and calf pens, feedlot and traditional swine, and feedlot and traditional beef. Several caged-layer, broiler, duck, and goose farms were visited, but no fly puparia were recovered.

Samples were collected by first locating groups of filth fly puparia in and around confinement areas, such as calf pens, cattle lots, swine pens, and manure piles. After collection, puparia or substrates containing puparia were placed in labeled containers and stored in insulated bags containing ice packs. Sample volume could not be standardized because of the variability of the substrates being sampled. However, we attempted to collect a minimum of 200 puparia at each site.

Samples were taken to the Department of Parasitology and Zoology, University of Veterinary Science in Budapest, where puparia were separated from substrates by flotation, air dried, and placed individually in 00 gelatin capsules. Encapsulated puparia were stored at room temperature in labeled containers. After the last collection was made and the samples were

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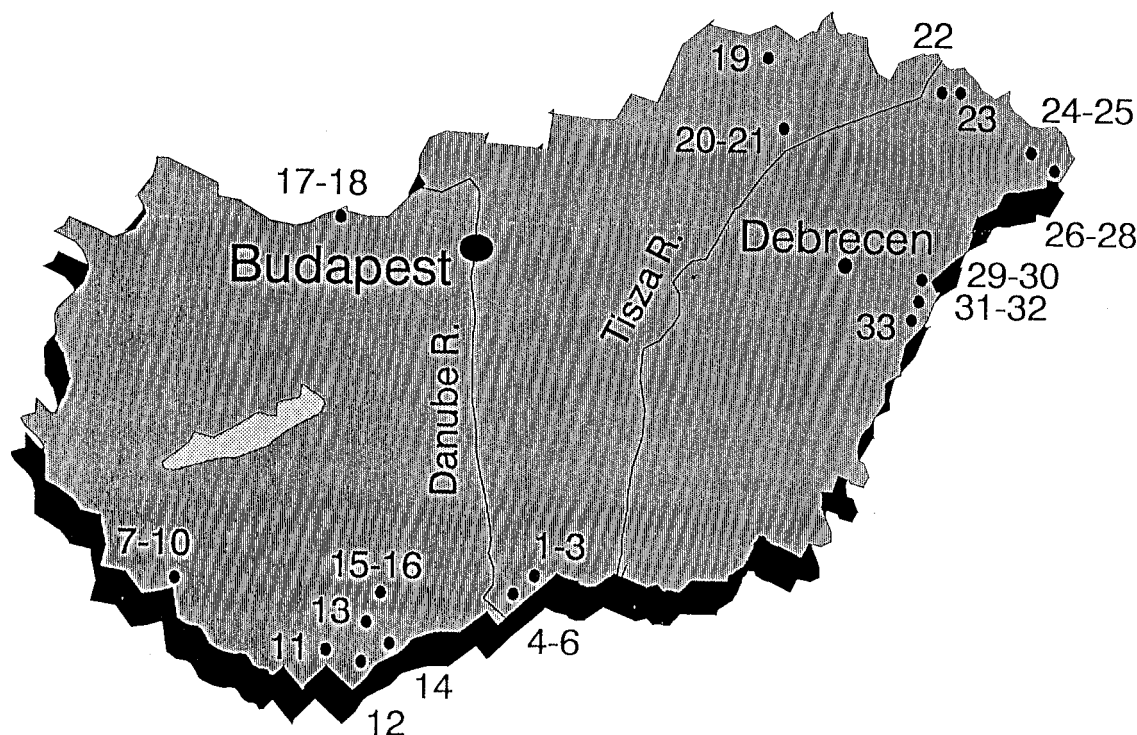


Fig. 1. Location of the sample farms in Hungary in 1996: 1-3, Bácsalmás; 4-6, Dávod; 7-10, Barcs; 11, Egyházasharaszti; 12, Beremend; 13, Villány; 14, Lapáncsa; 15-16, Bácsfalupuszta; 17-18, Komárom; 19, Hernádcéce; 20-21, Szerencs; 22, Tornyospálca; 23, Mezőladány; 24-25, Vámosoroszi; 26-28, Csengersima; 29-30, Bagamér; 31-32, Álmosd; 33, Létavértes.

processed, all encapsulated puparia were placed in sealed bags where the flies and parasitoids were allowed to complete their development. Samples were sorted at the Systematic Parasitoid Laboratory in Kőszeg, Hungary. Fly puparia were identified by R.F. and the parasitoids were identified by Cs.T. using the keys of Bouček (1963), Peck et al. (1964), and Rueda and Axtell (1985). Voucher specimens of these species have been deposited in the USDA Systematic Entomology Laboratory, Washington, DC; the Hungarian National Museum, Budapest; and the Systematic Parasitoid Laboratory, Kőszeg.

Results and Discussion

A total of 2,342 puparia was collected from which either a fly or a parasitoid emerged (Table 1). The two major filth fly species that eclosed were the house fly, *Musca domestica* L., and the stable fly, *Stomoxys calcitrans* (L.). Two parasitoids emerged from puparia of a calliphorid sp.

Three species of *Spalangia* were positively identified: *S. endius*, *S. cameroni* Perkins, and *S. nigroaenea* Curtis. *S. nigra* Latrielle, recovered in our previous study (Hogsette et al. 1994), was not found. The most numerous *Spalangia* sp., *S. cameroni*, was recovered from house fly and stable fly puparia collected from feedlot beef and dairy, and from stable fly puparia from calf bedding (usually straw) in Steinmann cages

(calf weaning pens) (Table 2). In the United States, *S. cameroni* is frequently listed as the most abundant *Spalangia* sp. found near confined livestock and poultry in the eastern and southwestern states (Legner and Olton 1971, Rutz and Axtell 1980, Butler et al. 1981, Greene et al. 1989, Miller and Rutz 1990).

Table 1. Number and species of flies and pupal parasitoids recovered from fly puparia collected on feedlot and traditional beef, feedlot and traditional dairies, and feedlot and traditional swine facilities in southern and eastern Hungary in 1996

Species recovered	Dipteran host		
	House fly	Stable fly	Calliphoridae
<i>Musca domestica</i>	1,151	—	—
<i>Stomoxys calcitrans</i>	—	698	—
<i>Spalangia endius</i>	67	27	—
<i>S. cameroni</i>	148	107	2
<i>S. nigroaenea</i>	81	40	—
<i>Muscidifurax raptor</i>	2	2	—
Diapriidae sp. (1)	9	—	—
Diapriidae sp. (2)	1	—	—
<i>Pachycrepoides vindemiae</i>	2	—	—
<i>Trichomalopsis</i> sp.	—	4	—
<i>Brachycera</i> sp.	1	—	—
Total parasitoids	311	180	2

Total parasitized pupae: 493. Total parasitoids: 493. Total pupae yielding either a fly or parasitoid = 1,151 (*M. domestica*) + 698 (*S. calcitrans*) + 493 (parasitized) = 2,342. Percentage parasitism = $(493/2,342) \times 100 = 21.1$.

Table 2. Number of flies and pupal parasitoids which emerged from viable filth fly puparia collected on farms in southern and eastern Hungary in 1996, summarized by location, collection date, and animal or substrate type

Location	Date (Aug. 1996)	Animal or substrate type	Emergence from house fly puparia						Emergence from stable fly puparia						Total puparia
			H.f.	S.e.	S.c.	S.n.	M.r.	other	S.f.	S.e.	S.c.	S.n.	M.r.	other	
Bácsalmás	18	Confined swine	62	15	—	—	—	—	5	—	—	—	—	—	360
Barcs	21	Confined swine	114	—	—	—	—	2 <i>P.v.</i> ^a	—	—	—	—	—	—	151
Barcs	21	Confined swine	88	—	—	2	—	—	—	—	—	—	—	—	140
Villány	22	Confined swine	95	6	1	1	—	—	—	—	—	—	—	—	137
Komárom	23	Confined swine	147	—	—	—	—	—	—	—	—	—	—	—	166
Komárom	23	Confined swine	117	—	—	—	—	—	—	—	—	—	—	—	136
Hernádcéce	26	Confined swine	8	2	2	—	—	—	—	—	—	—	—	—	33
Létavértes	28	Confined swine	14	21	—	5	—	—	—	—	—	—	—	—	71
Dávod	19	Penned swine ^b	1	—	3	—	—	—	2	—	—	—	—	—	14
Álmosd	28	Penned swine ^b	1	—	—	—	—	—	—	—	—	—	—	—	59
Bagamér	28	Penned swine ^b	6	—	2	5	—	—	1	—	—	—	—	—	40
Bácsalmás	18	Feedlot dairy	24	—	—	—	—	1 <i>B.sp.</i> ^c	7	—	—	—	—	—	270
Barcs	21	Feedlot dairy	12	—	2	—	—	—	63	—	3	1	—	—	192
Szerencs	26	Feedlot dairy	1	—	22	—	—	—	28	—	14	3	—	—	112
Csengersima	27	Feedlot dairy	—	—	—	—	—	—	17	—	7	5	—	—	55
Álmosd	28	Feedlot dairy	16	—	—	—	—	—	14	—	2	—	—	—	79
Barcs	21	Dairy-silage	30	—	3	—	—	9 <i>D.spl.</i> ^d	1	—	—	—	—	—	54
Bácsfalupuszta	22	Dairy-silage	86	—	18	1	—	—	—	—	—	—	—	—	147
Csengersima	27	Dairy-silage	244	—	—	51	1	1 <i>D.sp2.</i> ^e	—	—	—	1	—	—	412
Vámosoroszi	27	Dairy-silage	—	—	—	—	—	—	23	—	7	9	—	—	64
Bácsalmás	18	Dairy-calf pens ^f	10	1	5	1	—	—	6	—	3	1	—	—	82
Dávod	19	Dairy-calf pens ^f	8	—	1	—	—	—	30	—	5	1	1	—	139
Beremend	22	Dairy-calf pens ^f	2	3	—	4	1	—	45	12	8	7	1	—	216
Szerencs	26	Dairy-calf pens ^f	—	—	—	—	—	—	—	—	—	—	—	—	17
Csengersima	27	Dairy-calf pens ^f	—	—	1	—	—	—	88	—	6	—	—	—	162
Vámosoroszi	27	Dairy-calf pens ^f	—	—	—	—	—	—	90	—	20	9	—	—	214
Bagamér	28	Dairy-calf pens ^f	—	—	—	—	—	—	28	—	19	—	—	—	90
Dávod	19	Feedlot beef	22	19	88	11	—	—	2	—	1	—	—	—	467
Bácsfalupuszta	22	Feedlot beef	2	—	—	—	—	—	248	15	12	3	—	4 <i>T.sp.</i> ^h	365
Lapáncsa	22	Manure pile ^g	—	—	—	—	—	—	—	—	—	—	—	—	34
Egyházasharaszti	22	Manure pile ^g	37	—	—	—	—	—	—	—	—	—	—	—	76
Mezőladány	26	Manure pile ^g	1	—	—	—	—	—	—	—	—	—	—	—	155
Tornyospálca	26	Manure pile ^g	3	—	—	—	—	—	—	—	—	—	—	—	8

H.f., house fly; S.e., *Spalangia endius*; S.c., *S. cameroni*; S.n., *S. nigroaenea*; M.r., *Muscidifurax raptor*; S.f., stable fly.^a *Pachycrepoideus vindemiae*.^b Penned swine are on small, private, traditional Hungarian farms.^c *Brachycera* sp.^d Diapriidae sp. 1.^e Diapriidae sp. 2.^f Steinmann cages used to house calves during the weaning period.^g Manure piles at private farms consisting of a mixture of cattle and swine manures, and straw bedding.^h *Trichomalopsis* sp.

A large number of the second most abundant parasitoid, *S. nigroaenea*, was recovered from house fly puparia in dairy silage in Csengersima (Fig. 1; Table 2), but it was otherwise found in low numbers in house flies. *S. nigroaenea* was recovered from stable fly puparia from feedlot dairy, dairy silage, and calf bedding in Steinmann cages, but numbers were also low (Table 2). *S. nigroaenea* is the major parasitoid attacking filth fly puparia on beef feedlots in Illinois (Jones and Weinzierl 1997) and western Kansas (Greene 1990). The third most abundant parasitoid, *S. endius*, was recovered from stable fly and house fly puparia on feedlot beef and calf bedding in Steinmann cages, and from house fly puparia on confined swine facilities (Table 2). *Muscidifurax raptor* was recovered from house fly and stable fly puparia in calf bedding in

Steinmann cages and from house fly puparia in dairy silage (Table 2).

Two Diapriidae spp. and one *Brachycera* sp., all apparently undescribed, were recovered. Diapriidae sp. 1 and sp. 2, both solitary species, emerged from house fly puparia collected in dairy silage near Barcs and Csengersima, respectively (Fig. 1; Table 2). The single *Brachycera* sp. was recovered from a house fly puparium from a dairy feedlot in Bácsalmás. Two *Pachycrepoideus vindemiae* Rondani were recovered from house fly puparia collected on confined swine facilities in Barcs, and four *Trichomalopsis* sp. were recovered from stable fly puparia in feedlot beef in Bácsfalupuszta (Fig. 1; Table 2).

No fly puparia were recovered from any of the poultry facilities visited because of the existing man-

agement practices. Belt systems were used for manure collection on caged-layer farms, thus precluding the on-site collection of manure and its use by flies. Filth flies are not usually a problem on well managed broiler farms, and this was the case at the farms we visited. Ducks and geese were housed indoors overnight, but spent much of the daylight hours in large outdoor pens or on pasture. We attributed the lack of fly breeding to the dry conditions in indoor and outdoor sites.

This is the second field survey of parasitic Hymenoptera of filth flies performed in Hungary and it is intended to complement our previous survey (Hogsette et al. 1994). From the limited documentation we found in the literature, it appears that some of our species are new records for the country. *P. vin-demiae* was found in pupae of muscoid Diptera in collections made in Europe (Peck et al. 1964, Fabritius 1981, Rueda and Axtell 1985), and in various parts of the U.S. (Pickens et al. 1975, Geden et al. 1992, Petersen and Watson 1992, Jones and Weinzierl 1997); and it is considered to be cosmopolitan (Graham 1969). We know of no previous Hungarian collections.

Several species of *Trichomalopsis*, particularly *Trichomalopsis dubius* Ashmead, have been collected and studied in various parts of North America (Hoebeke and Rutz 1988, Geden et al. 1992, Dobesh et al. 1994, Lysyk 1998). However, Graham (1969) suggests that *Trichomalopsis* Crawford might be the same as *Eupteromalus* Kurdjumov; many European species of *Eupteromalus* are undescribed and the entire group needs revision. Kamijo and Grissell (1982) have since placed the genus *Eupteromalus* as a synonym of *Trichomalopsis*. Several species of *Eupteromalus* have been collected in the former Czechoslovakia (Graham 1969), but we are not aware of any collections of either *Trichomalopsis* or *Eupteromalus* in Hungary. The two undescribed species of Diapriidae and the undescribed species of *Brachycera* are probably new country records. Apparently present in small numbers, it is doubtful that these have been collected in Hungary.

As in our previous survey, *Spalangia* was the most numerous parasitoid genus and comprised 95.7% of the parasitoids recovered. *M. raptor*, another cosmopolitan species (Peck et al. 1964), was again recovered, but only four specimens (0.8% of the total parasitoids) were collected. We collected 55 *M. raptor* during our previous survey, but this is still a relatively small number (4.7% of the parasitoids) compared with other geographic locations (Miller and Rutz 1990).

Although the number of collected pupae that produced either a fly or a parasitoid was similar in 1991 (2,946) and 1996 (2,342), the rate of parasitism in 1996 (21.1%) (Table 1) was approximately half of that observed in 1991 (39.7%) (Hogsette et al. 1994). This could be due to differences in sampling location and facility type, or variation in precipitation and other meteorological factors.

Differences in management techniques at the sample facilities were important. In confined swine, for example, house fly pupae could usually be found after careful searching. But manure management and pen sanitation usually involved water, which made most

confined swine facilities unsuitable for parasitoids because of the high moisture content of the substrate. Pyrethroid pesticides used on some facilities could also be detrimental to parasitoid populations.

In 1991, samples were collected from two feedlot dairies, both of which had calves in Steinmann cages. Pupae in calf pen areas were present in large numbers, and the predominant host was the house fly (Hogsette et al. 1994). In 1996, seven farms were visited where calves were present in Steinmann cages. Compared with 1991, viable pupae were few and stable fly was the predominant host species. On many of these farms, the Steinmann cages were moved at intervals and dry bedding was added regularly which kept substrate beneath calves dry and inadvertently helped break fly life cycles. Straw was again found to be routinely used throughout Hungary for animal bedding, and fly pupae were generally mixed in loose and compressed mats of straw.

Our results complement those from 1991 (Hogsette et al. 1994), and indicate that a variety of filth fly pupal parasitoids are present on livestock farms in southern and eastern Hungary. In the current study, three species of *Spalangia* predominated, but *M. raptor*, *P. vin-demiae*, *Trichomalopsis*, and other species were also present. Collections must now be made from Lake Balaton west to the Austrian border, and north to south between the Danube and Tisza rivers to complete this series of surveys to identify the hymenopteran parasitoid fauna associated with filth flies in Hungary. At the moment, the *Spalangia* species appear to be strong candidates for use in filth fly biological control programs. However, individual parasitoid species cannot be selected until biology, seasonality, species composition, and efficacy studies have been completed on a variety of livestock facilities in different parts of the country.

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